# CRUDE OIL TRANSFER SAFETY ANALYSIS AND OIL SPILLS PREVENTION IN PORT OIL TERMINAL

PRESENTATION AT HAZARD WORKSHOP ORGANIZED BY PSRA ON 15.02.2019 IN GDYNIA.

**WP4 RISK ASSESSMENT AND ANALYSIS**
**4.1 RISK ASSESSMENT METHODS & MODELS**
**4.2 IMPROVED USE OF RISK ASSESSMENT METHODS**

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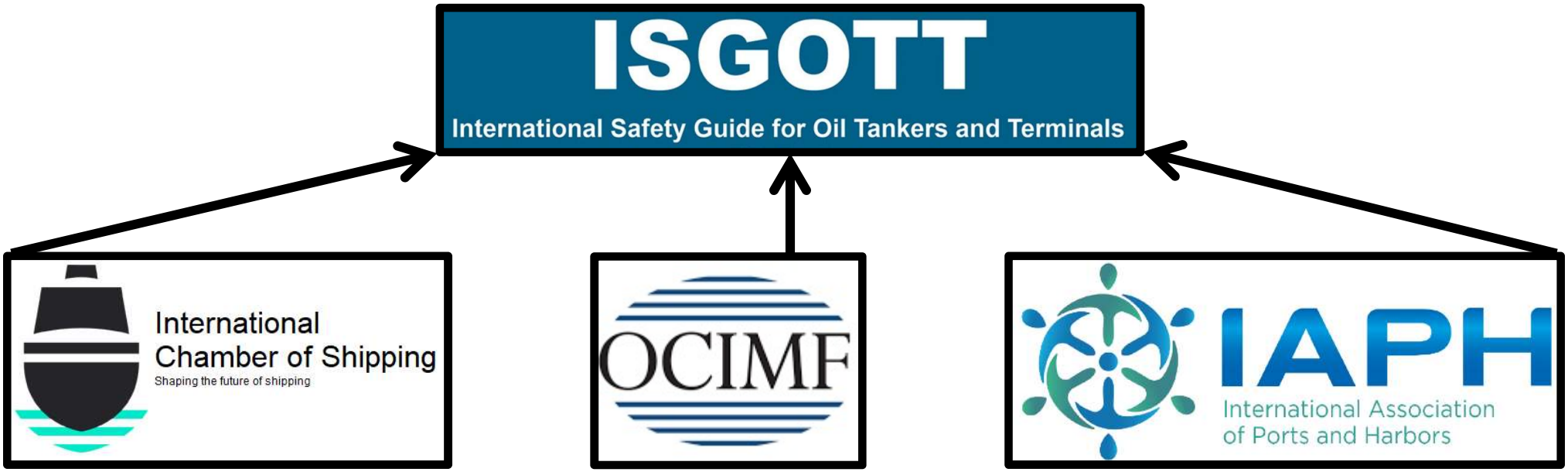
# Safety procedures during cargo transfers

International Safety Guide for Oil Tankers & Terminals (ISGOTT): Standard and major reference to safety onboard tankers and oil terminals. Document was prepared in collaboration of the *International Chamber of Shipping* (ICS) with the *Oil Companies International Marine Forum* (OCIMF) and the *International Association of Ports and Harbors* (IAPH). ISGOTT is a guide and does not impose obligations on involved parties. However, meeting its requirements is unwritten rule for the major oil companies to keep the highest quality of work and safety standards.



# Overview of the guidelines and procedures – ISGOTT

The last edition of ISGOTT is divided into **four main parts**:

1. **General information** – contains basic information on the treatment of petroleum, its derivatives and their physical/chemical properties. Special attention should be paid to flammability and toxicity, as well as to the danger associated with electricity in the area of explosive gases.
2. **Tanker information** - presents the safety aspects of the ship. Includes procedures for enclosed space entry or storing dangerous goods. Human factor is also taken into account - fatigue and drugs policy are discussed.
3. **Terminal information** - concerns the organization and security of the terminal and equipment for the ship. Guidelines for loading and discharging, as well as organization of evacuation can be found.
4. **Management of the tanker and terminal interface** – contains situations in which both the ship and the shore are involved, such as communication, mooring and unmooring. An example of the *Ship/Shore Safety Checklist* was presented, and the procedures were described in the event of a fire or explosion.

# Tanker and Oil Terminal Interface

*The critical place where two worlds meet.*

# Ship/Shore Safety Check List (SSSCL)

List of checks corresponding to the preparation of safe transfer of liquid cargo between tanker and the terminal. The responsibility and accountability for the safe conduct of operations while a ship is at an oil terminal are shared jointly between the ship's Master (or his representative) and the Terminal Representative

## 26.3.3 The Ship/Shore Safety Check-List

Ship's Name _____

Berth _____ Port _____

Date of Arrival _____ Time of Arrival _____

Part 'A' – Bulk Liquid General – Physical Checks

| Bulk Liquid – General | Ship | Terminal | Code | Remarks |
|---|---|---|---|---|
| 1. There is safe access between the ship and shore. | | | R | |
| 2. The ship is securely moored. | | | R | |
| 3. The agreed ship/shore communication system is operative. | | | A R | System:<br>Backup System: |
| 4. Emergency towing-off pennants are correctly rigged and positioned. | | | R | |
| 5. The ship's fire hoses and fire-fighting equipment are positioned and ready for immediate use. | | | R | |
| 6. The terminal's fire-fighting equipment is positioned and ready for immediate use. | | | R | |
| 7. The ship's cargo and bunker hoses, pipelines and manifolds are in good condition, properly rigged and appropriate for the service intended. | | | | |
| 8. The terminal's cargo and bunker hoses or arms are in good condition, properly rigged and appropriate for the service intended. | | | | |

# Ship/Shore Safety Check List (SSSCL)

SSSCL comprises four main parts (A-D):

- Part A - physical checks for transfer of Bulk Liquids (applicable to all operations).
- Part B - verbal checks for transfer of Bulk Liquids (applicable to all operations).
- Part C - additional requirements for transfer of Bulk Liquid Chemicals.
- Part D - additional requirements for transfer of Bulk Liquefied Gases.

Coding of items inside the checklist:

- **A** (*Agreement*). This indicates an agreement or procedure that should be identified in the *Remarks* column of the SSSCL or communicated in some other mutually acceptable form.
- **P** (*Permission*). In the case of a negative answer to the statements coded *P*, operations should not be conducted without the written permission from the appropriate authority.
- **R** (*Re-check*). This indicates items to be re-checked at appropriate intervals, as agreed between both parties, at periods stated in the declaration.

# Selected critical safety issues from SSSCL : Parts A-C

## **Part A** – Bulk Liquid General - **physical checks**

7. The ship's cargo and bunker hoses, pipelines and manifolds are in good condition, properly rigged and appropriate for the service intended.

*Hoses should be in a good condition and properly fitted and rigged so as to prevent strain and stress beyond design limitations.*

*All flange connections should be fully bolted and any other types of connections should be properly secured.*

# **Part A** – Bulk Liquid General - **physical checks**


*Hoses and pipelines should be constructed of a material suitable for the substance to be handled, taking into account its temperature and the maximum operating pressure.*

*Cargo hoses should be indelibly marked so as to allow the identification of the products for which they are suitable, as well as their operational properties.*

# **Part A** – Bulk Liquid General - **physical checks**

13. The ship's unused cargo and bunker connections are properly secured with blank flanges fully bolted.

*Unused cargo and bunker line connections should be closed and blanked. Blank flanges should be fully bolted and other types of fittings, if used, properly secured.*

14. The terminal's unused cargo & bunker connections are properly secured with blank flanges fully bolted.

# **Part A** – Bulk Liquid General - **physical checks**

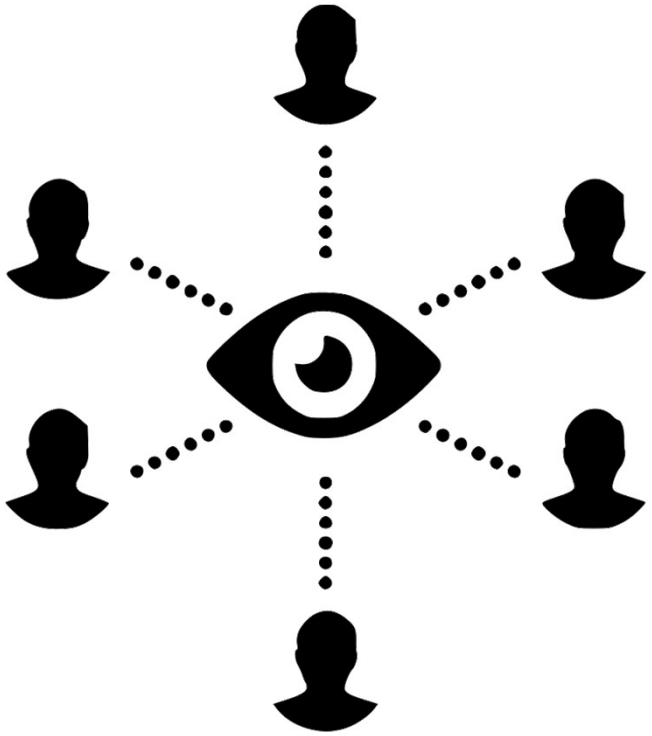
16. Sea and overboard discharge valves, when not in use, are closed and visibly secured.

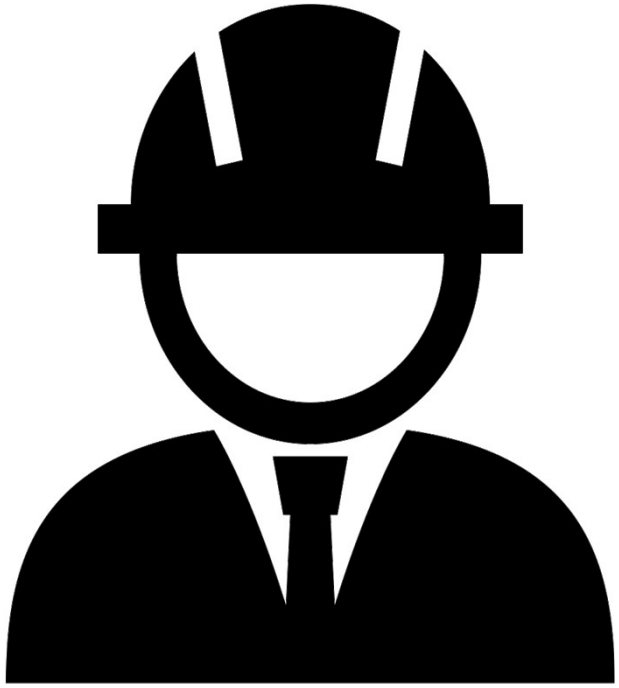
*Remote operating controls for such valves should be identified in order to avoid inadvertent opening. If appropriate, the security of the valves in question should be checked visually.*

# **Part B** – Bulk Liquid General - **verbal verification**

22. There is an effective deck watch in attendance on board and adequate supervision of operations on the ship and in the terminal.

23. There are sufficient personnel on board and ashore to deal with an emergency.





*The operation should be under constant control and supervision on ship and ashore. Supervision should be aimed at preventing the development of hazardous situations. However, if such a situation arises, the controlling personnel should have adequate knowledge and the means available to take corrective action.*

# **Part B** – Bulk Liquid General - **verbal verification**

24. The procedures for cargo, bunker and ballast handling have been agreed.

*The procedures for the intended operation should be pre-planned. They should be discussed and agreed upon by the Responsible Officer and Terminal Representative prior to the start of the operations. Agreed arrangements should be formally recorded and signed.*

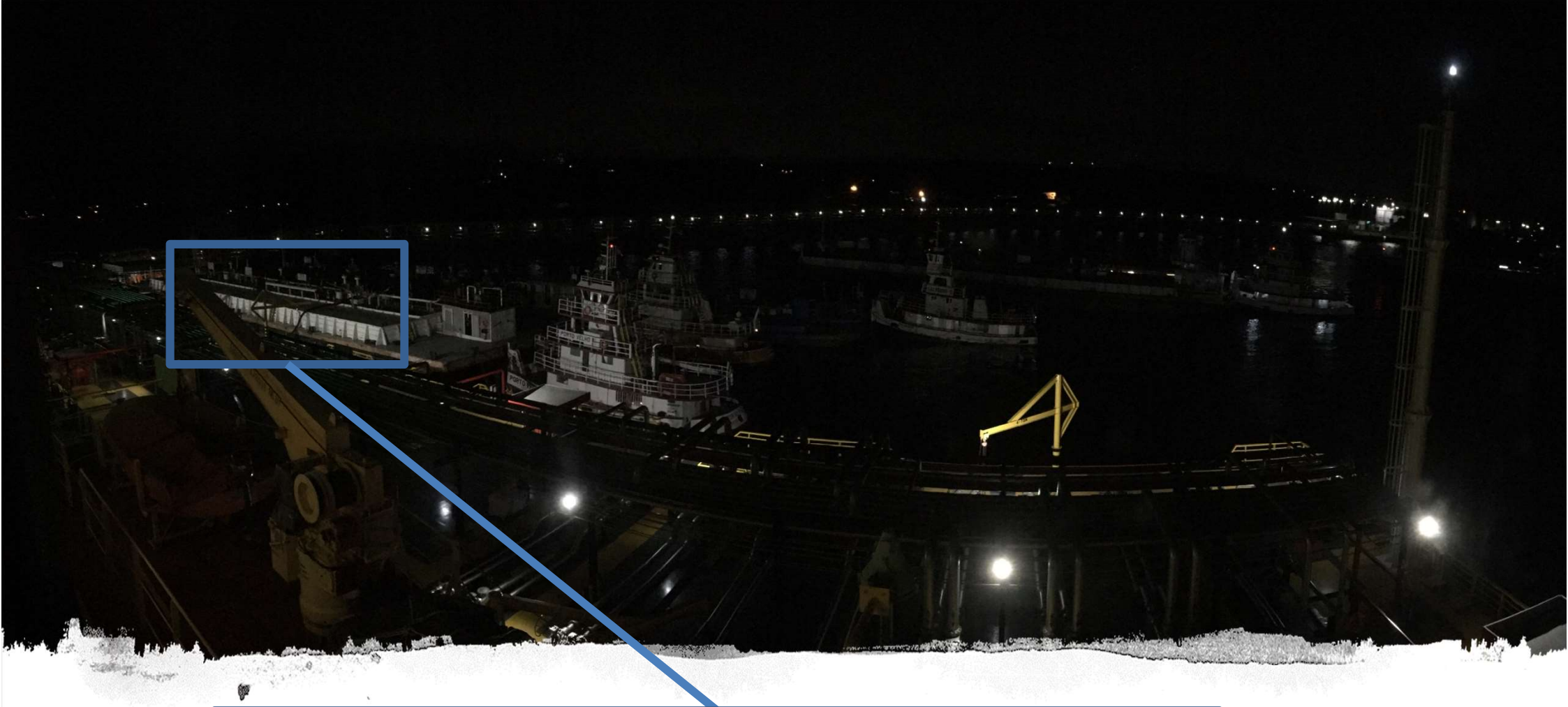
*The initial and maximum loading rates, topping-off rates and normal stopping times should be agreed, having regard to:*

- *The nature of the cargo to be handled.*
- *The arrangement and capacity of the ship's cargo lines and gas venting systems.*
- *The maximum allowable pressure and flow rate in the ship/shore hoses and loading arms.*
- *Precautions to avoid accumulation of static electricity.*
- *Any other flow control limitations.*

# SSSCL **Part B** – Bulk Liquid General- **verbal verification**

*The manifold areas, both on board and ashore, should be safely and properly illuminated during darkness.*


Positive examples of product tanker in the oil terminal during loading in Rio Grande, Brazil (August, 2018)



*„The manifold areas, both on board and ashore, should be safely and properly illuminated during darkness".*

# GUIDELINES vs REALITY

Negaitve example of oil terminal in Manaus, Brazil (June, 2018)

# SSSCL **Part B** – Bulk Liquid General - **verbal verification**

25. The emergency signal and shutdown procedure to be used by the ship and shore have been explained and understood.

*The agreed signal to be used in the event of an emergency arising ashore or on board should be clearly understood by shore and ship personnel.*

*An emergency shutdown procedure should be agreed between ship and shore, formally recorded and signed by both the ship and terminal representative.*

*The agreement should state the circumstances in which operations have to be stopped immediately.*

# SSSCL **Part B** – Bulk Liquid General - **verbal verification**

31. The operation of the P/V system has been verified.

*The operation of the P/V valves and/or high velocity vents should be checked using the testing facility provided by the manufacturer. Furthermore, it is imperative that an adequate check is made, visually or otherwise, to ensure that the checklift is actually operating the valve. On occasion, a seized or stiff vent has caused the checklift drive pin to shear and the ship's personnel to assume, with disastrous consequences, that the vent was operational.*

# The operation of the P/V system has been verified – movie

# SSSCL **Part B** – Bulk Liquid General- **verbal verification**

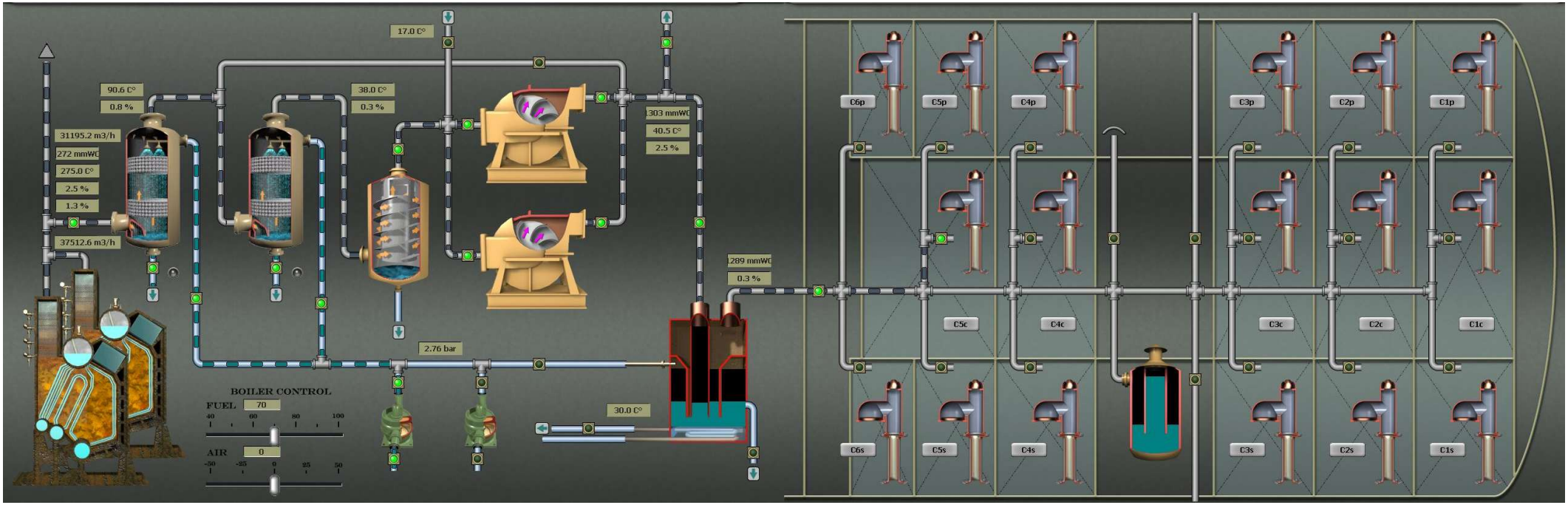
33. Independent high level alarms, if fitted, are operational and have been tested.

*The overfill alarm should provide audible and visual indication and should be set at a level which will enable operations to be shut down prior to the tank being overfilled. Under normal operations, the cargo tank should not be filled higher than the level at which the overfill alarm is set.*


# SSSCL **Part B** – Bulk Liquid General - **verbal verification**

50. The IGS is fully operational and in good working order.

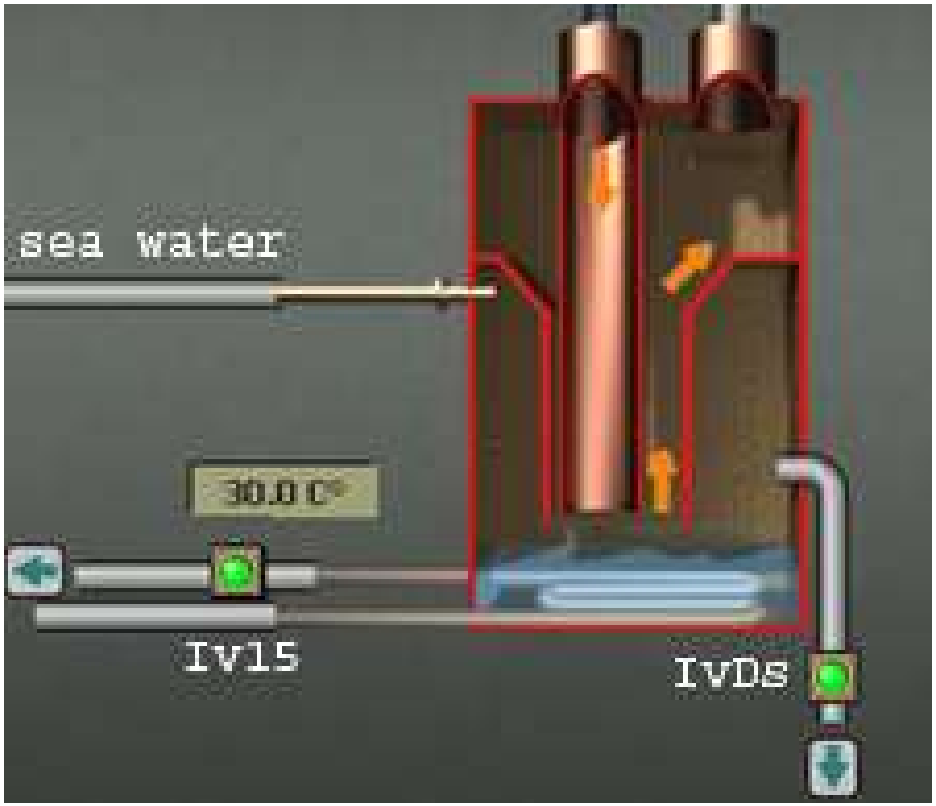
*The inert gas system should be in safe working condition with particular reference to all interlocking trips and associated alarms, deck seal, non-return valve, pressure regulating control system, main deck IG line pressure indicator, individual tank IG valves (when fitted) and deck P/V breaker.*



# SSSCL Part B – Bulk Liquid General - verbal verification

51. Deck seals, or equivalent, are in good working order.

*It is essential that the deck seal arrangements are in a safe condition.*
*In particular, the water supply arrangements to the seal and the proper functioning of associated alarms should be checked.*




# SSSCL **Part C** – Bulk Liquid Chemicals – **verbal verification**

5. The cargo handling rate is compatible with the automatic shutdown system, if in use.

*Automatic shutdown valves may be fitted on the ship and ashore.*
*The action of these is automatically initiated, for example, by a certain level being reached in the ship or shore tank being filled.*

*Where such systems are used, the cargo handling rate should be established to prevent pressure surges from the automatic closure of valves causing damage to ship or shore line systems. Alternative means, such as a re-circulation system and buffer tanks, may be fitted to relieve the pressure surge created.*

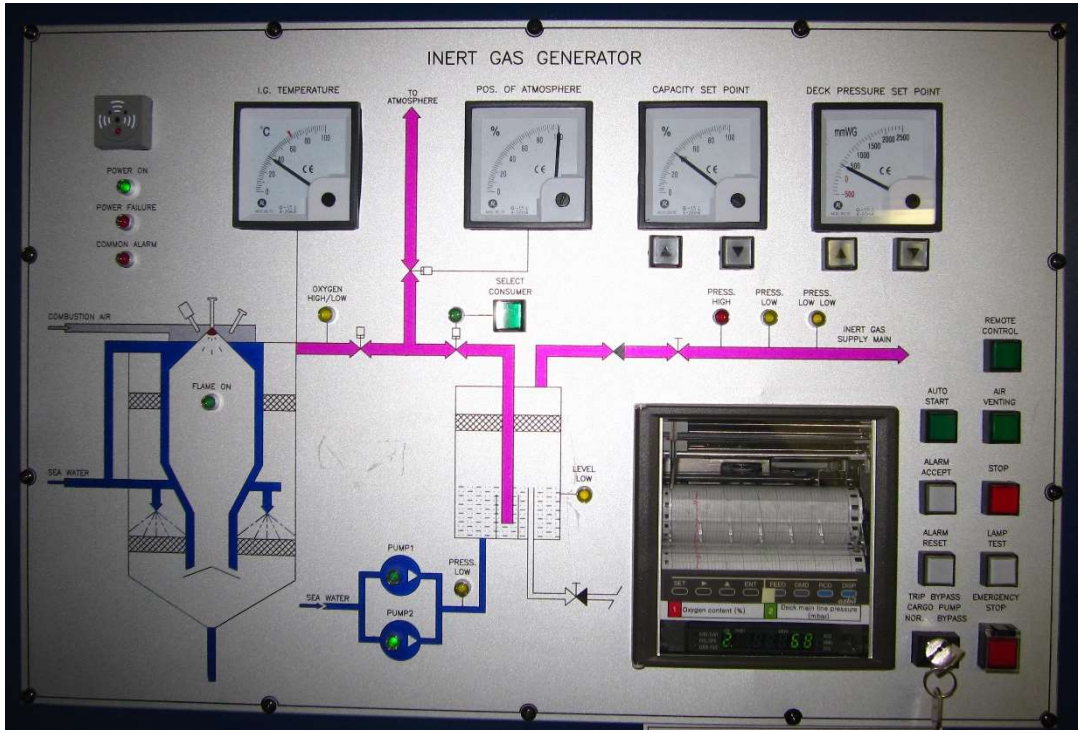
$$Q_{max} = \frac{\pi d^2 v_{max}}{4} = \frac{\pi d^2 P_{max}}{4\rho c} = 0{,}025 d^2 P_{max}$$

*where:*
$Q_{max}$ *- transfer rate [m³/h];*
$d$ *- diameter of the pipeline[m];*
$P_{max}$ *- max. pressure [Pa]*

# SSSCL **Part C** – Bulk Liquid Chemicals – **verbal verification**

## 6. Cargo system gauges and alarms are correctly set and in good order.

*Ship and shore cargo system gauges and alarms should be regularly checked to ensure they are in good working order.*
*In cases where it is possible to set alarms to different levels, the alarm should be set to the required level.*

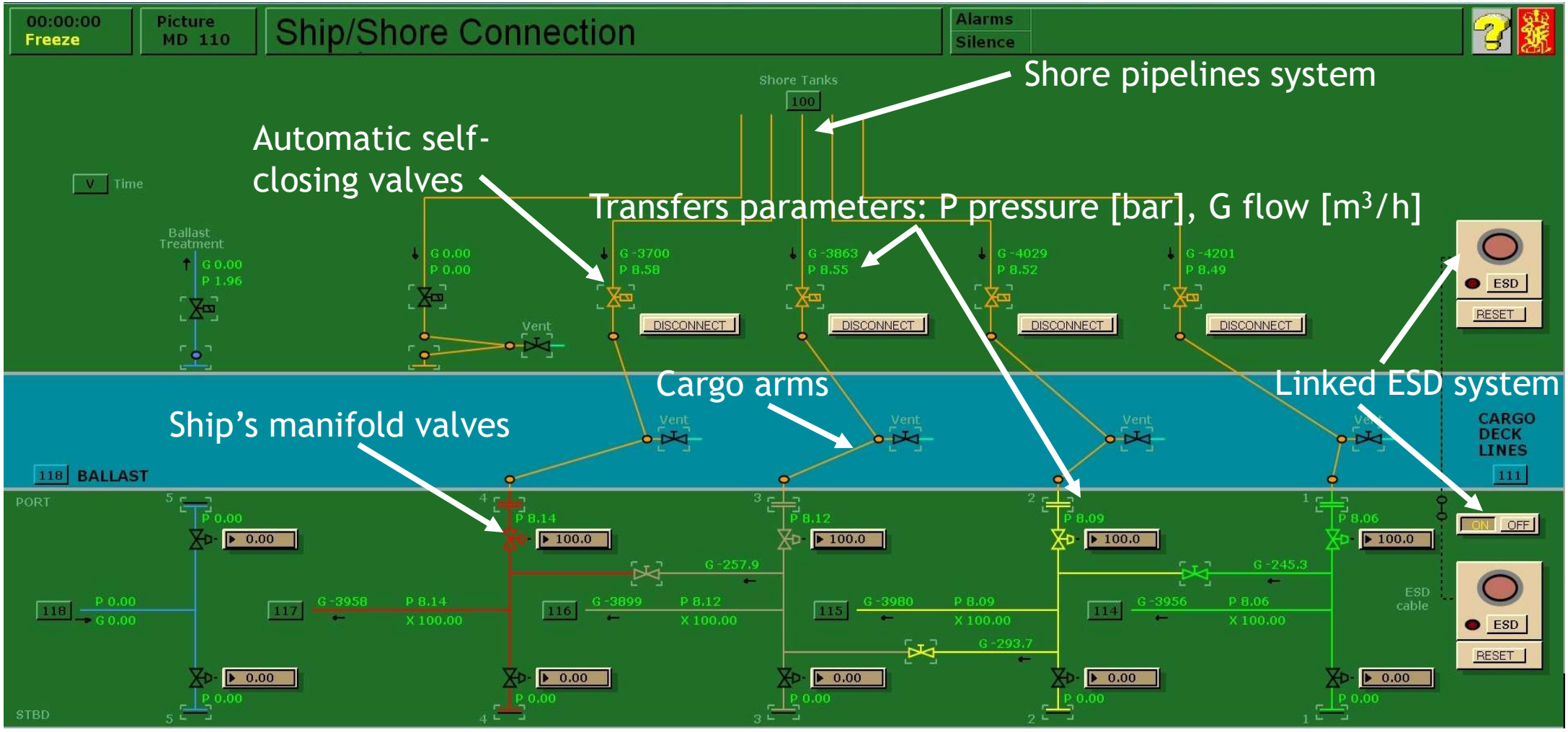




# LCHS – Improve your skills in controlled conditions

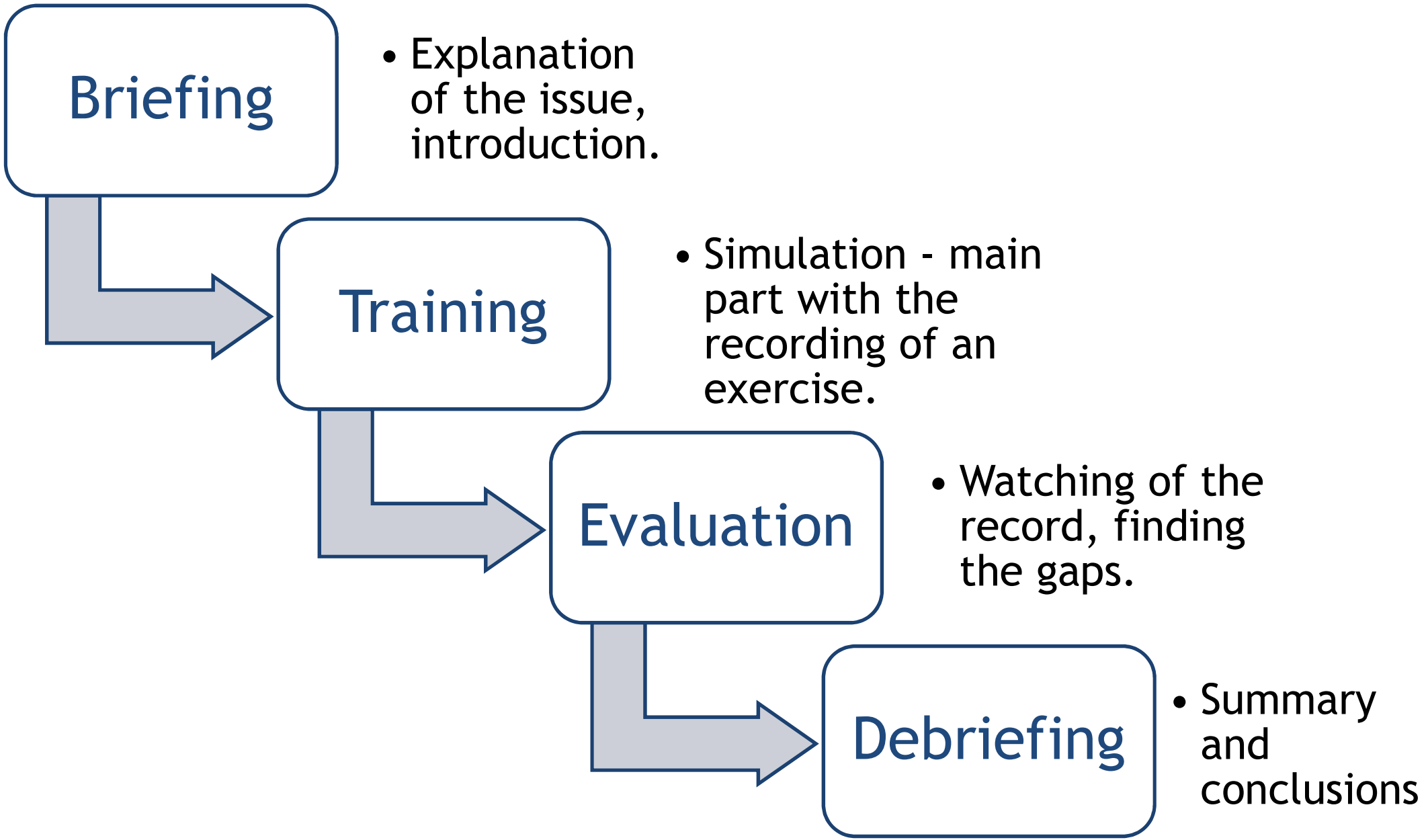
The basic method to reduce possibility of human erroneous among the crewmembers is regular skills improvement. The simplest option to gain experience in safe and controlled conditions is utilization of the simulators. Possibility to make a mistake, even lead to the accident or oil spill during the exercises could improve the knowledge of the trainees and prevent repetition of the same situation in the reality.

Gdynia Maritime University has got the facilities to provide the trainings for the tankers' crew, as well as the terminal workers. The two Liquid Cargo Handling Simulators (LCHS) allow to carry out advanced trainings for the different types of liquid cargo. The software and the interface of LCHSs is similar to the cargo computers used in the CCRs (Cargo Control Rooms) onboard tankers or gas carriers.

## Oil Terminal & VLCC tanker connections – LCHS view



# Our approach to training on LCHS



# Emergency Shutdown System (ESD) : Introduction


ESD systems for cargo transfers are used to stop the flow of cargo liquid and vapour in an emergency and to bring the cargo handling system to a safe, static condition.

It is recommended that linked ESD systems are installed so that an ESD trip activated on the ship will send an ESD signal to the terminal and vice versa.

A core recommendation is that, as a minimum, ESD is manually activated.

# SSL - Ship/Shore Link

The purpose of the SSL is to transmit, without delay, a signal from ship to terminal or vice versa.

For oil and chemical transfers, the minimum recommendation is to use an electric SSL that incorporates a 5-pin twist connector.

# Emergency Shutdown System (ESD)

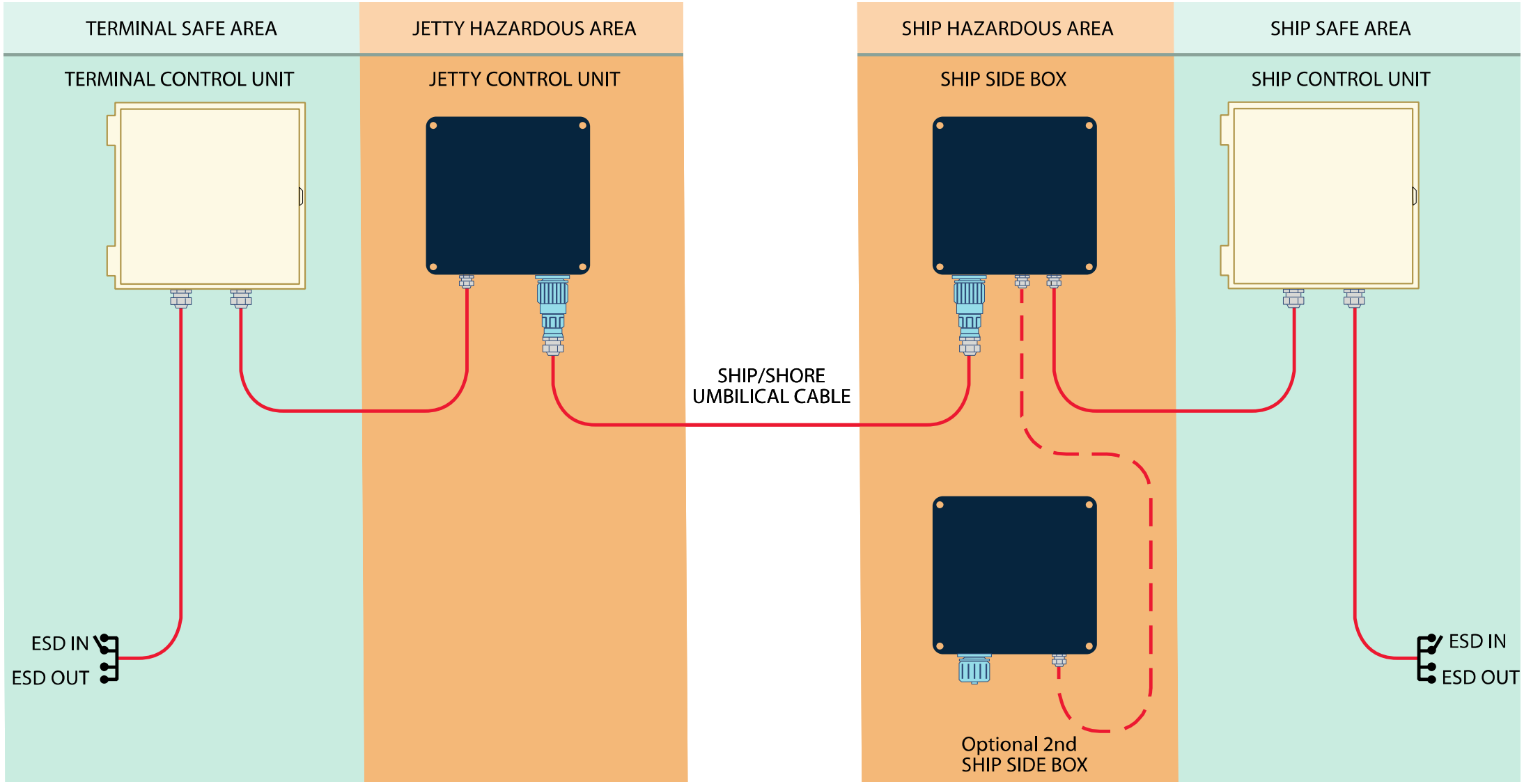
In a linked ESD system, the party receiving cargo, i.e. the ship in the loading port and the terminal in the discharge port, can stop cargo flow by shutting down the transfer pumps in a controlled way.

The receiving party should never have to shut valves against a full flow of incoming liquid.

A linked system also allows either party to activate a controlled shutdown of the transfer process if a leakage or fire is discovered, without generating unacceptable surge pressures in the pipework that would make the situation worse.

Once the ESD has been activated, further action may need to be taken to secure ship and terminal systems.

# Example of ship/shore ESD configuration



# Ship to Terminal transfers

Activation of ESD should trip visual and audible alarms on the ship and terminal and the following actions.

| Ship | | Terminal |
|---|---|---|
| Transmits ESD trip signal to terminal via SSL. | → | Receives ESD trip signal from ship. |
| | or | |
| Receives ESD trip signal from terminal. | ← | Transmits ESD trip signal to ship via SSL. |
| Stops cargo flow by tripping ship's cargo transfer pumps. | | |
| **Optional** | | |
| Closes ship's manifold valves in a safe manner, taking account of potential surge issues. | | Closes terminal's ESD valves in a safe manner, taking account of potential surge issues. |

**Table 3.2**: *ESD actions for ship to terminal transfers*

# Terminal to ship transfers

Activation of ESD should trip visual and audible alarms on the ship and terminal and the following actions.

| Ship | | Terminal |
|---|---|---|
| Transmits ESD trip signal to terminal via SSL. | → | Receives ESD trip signal from ship. |
| | or | |
| Receives ESD trip signal from terminal. | ← | Transmits ESD trip signal to ship via SSL. |
| | | Stops cargo flow, either by tripping terminal's cargo transfer pumps or by other safe means. |
| **Optional** | | |
| Closes ship's manifold valves in a safe manner, taking account of potential surge issues. | | Closes terminal's ESD valves in a safe manner, taking account of potential surge issues. |

**Table 3.1**: *ESD actions for terminal to ship transfers*

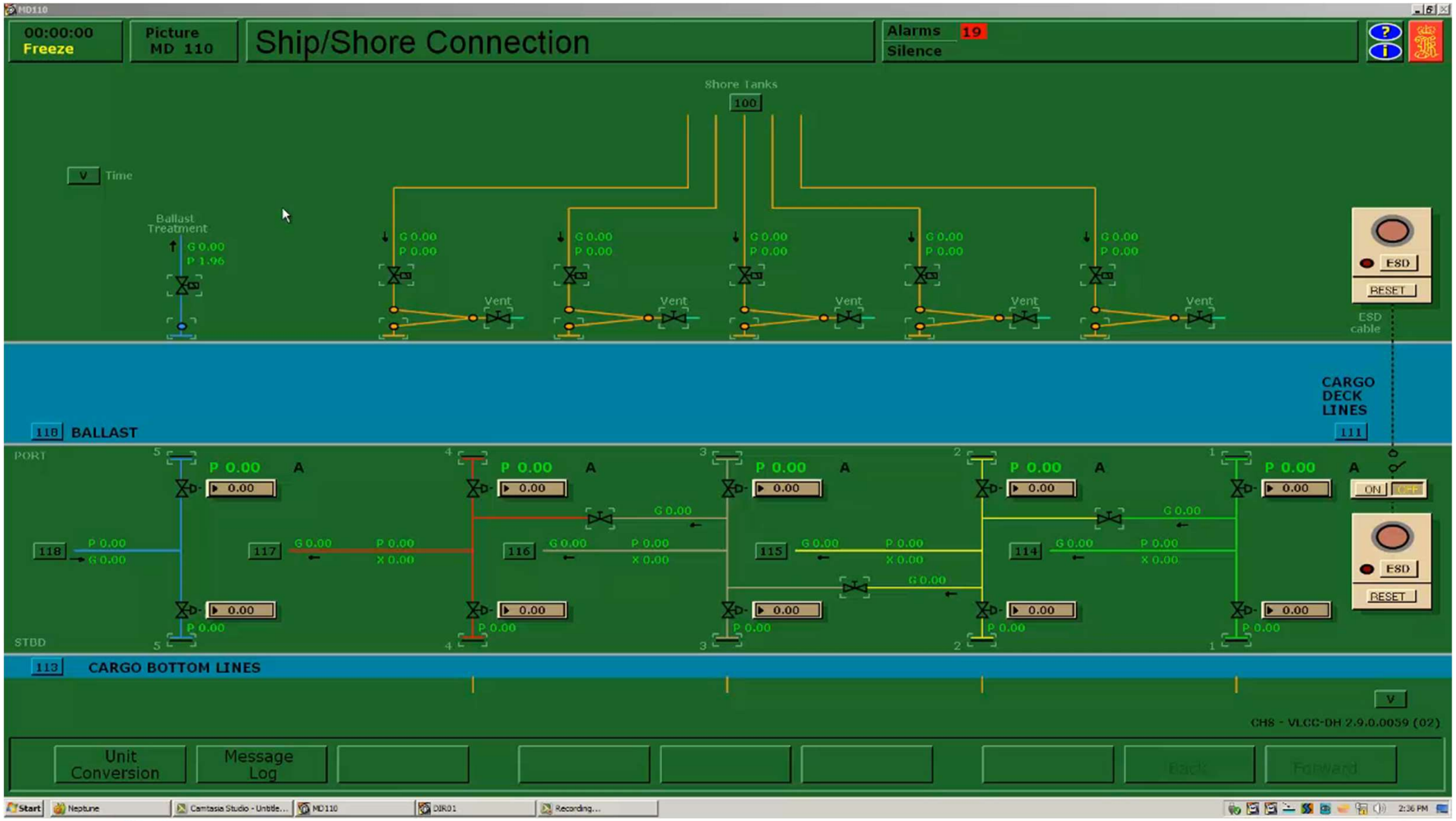
# Safety procedures during cargo loading

Preparations for loading the tanker using single line from oil terminal.

**Terminal:**

- Line-up cargo line in oil terminal,
- Check all valves on shore pipeline to cargo manifold,
- Check all controls on shore pipelines,
- Fill up cargo pumps with cargo,
- Start cargo pump with minimum capacity,
- Check once again all controls on shore pipelines,
- Open discharging valve,
- Open terminal manifold valve,
- Wait for confirmation from tanker that cargo is received,
- Wait for test ESD activated from tanker,
- Observed test results, confirm alarms,
- Reset all setting to the normal mode,
- Wait for tanker readiness to receiving cargo.

# Safety procedures during cargo loading: TERMINAL



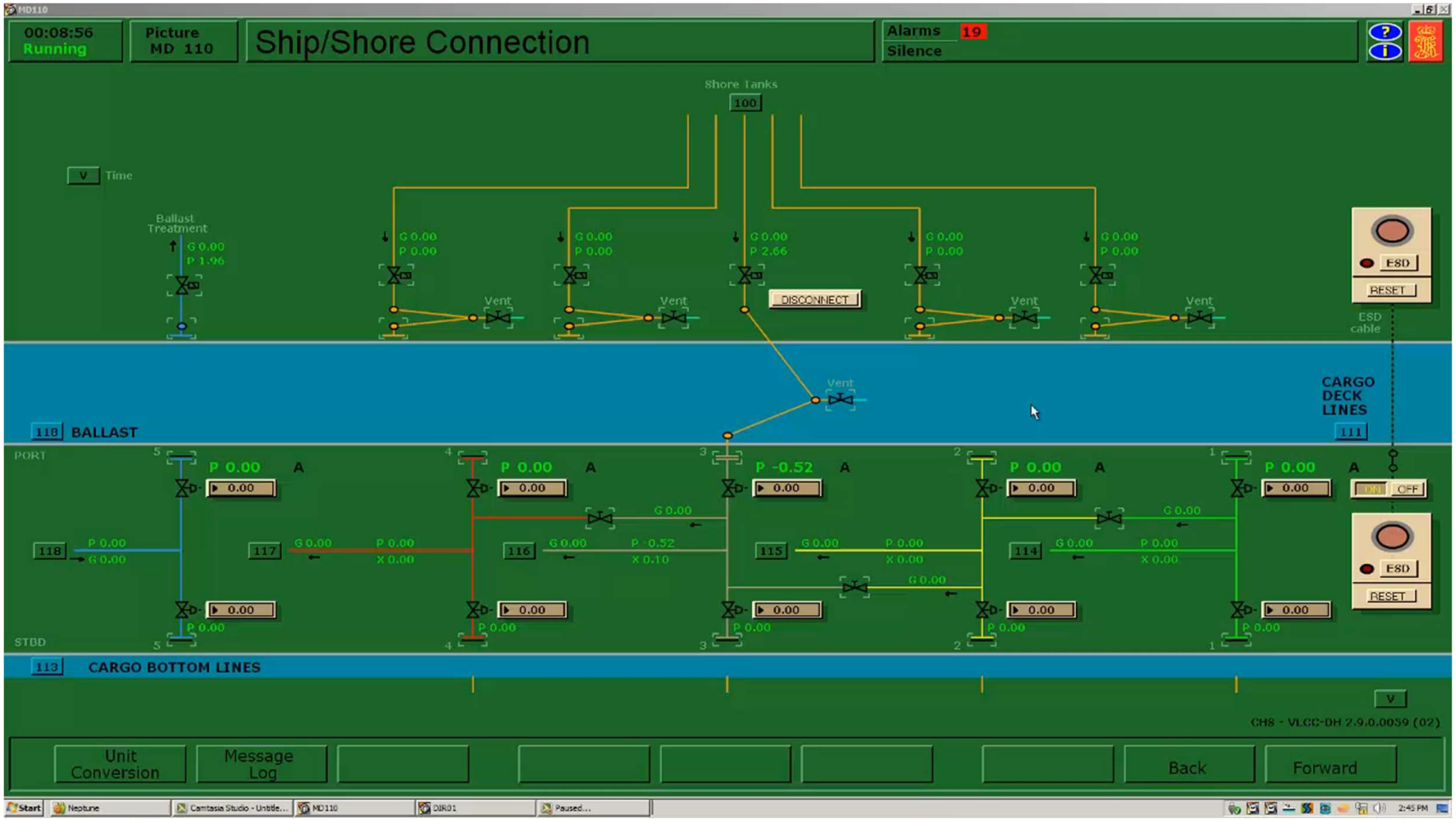
# Safety procedures during cargo loading

Preparations for loading the tanker using single line from oil terminal.

**Tanker:**

- Line-up cargo line for loading,
- Check all valves from designated cargo tanks to ship's manifold,
- Check all controls on cargolines,
- Open cargo manifold,
- Check all valves on cargo manifolds,
- Check all gauges on cargo manifolds,
- Check the pressure in presently loading tank,
- Confirm to terminal that cargo is received,
- Test ESD (to stop shore cargo pumps) before loading,
- Observed test results, confirm alarms,
- Restet all setting to the normal mode,
- Confirm to the oil terminal readiness to receiving cargo.

# Safety procedures during cargo loading: TANKER



# Associated safety systems - Emergency disconnection of loading arms

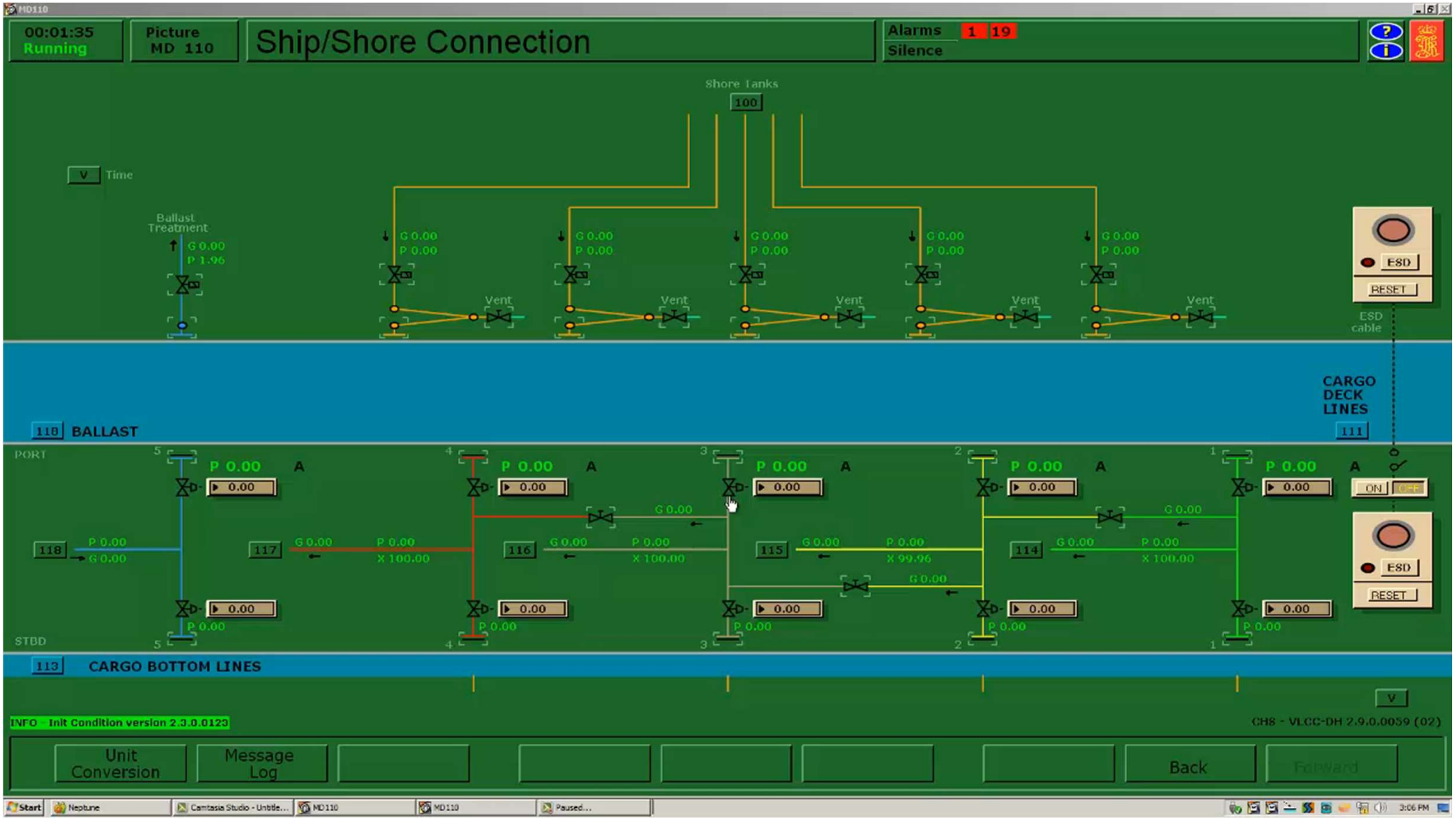
For an oil terminal to be able to disconnect loading arms from the ship in an emergency, an ERS (Emergency Release System) should be provided with a PERC (**Powered Emergency Release Coupling)** incorporated into each arm.This allows disconnection with minimum spillage, known as the dry-break concept. The ERS should only be activated after the ESD has been activated.

The sequence of actions on the terminal is as follows:
1. ESD activated (either on the terminal or ship, manually or automatically).
2. ERS activated (either manually or automatically).
3. ERS valves close (automatically).
4. PERC activated (automatically).
5. Loading arms disconnected (automatically).

It is recommended that when an ERS is activated a loud audible and highly visible alarm is triggered on the jetty.
This will warn personnel to stand clear of the ship’s manifold area and the jetty working platform.

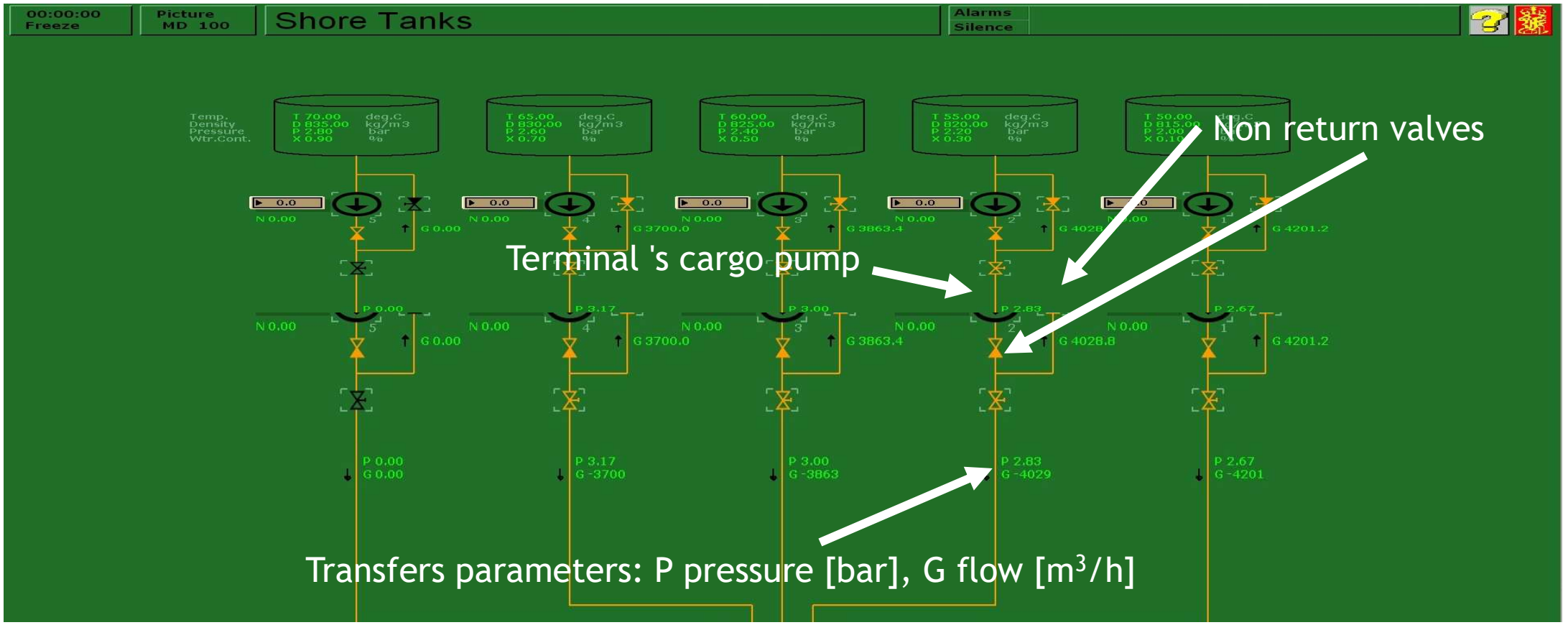
After ERS activated either manually or automatically loading arms are disconnected.

# Emergency disconnection of loading arm - ERS



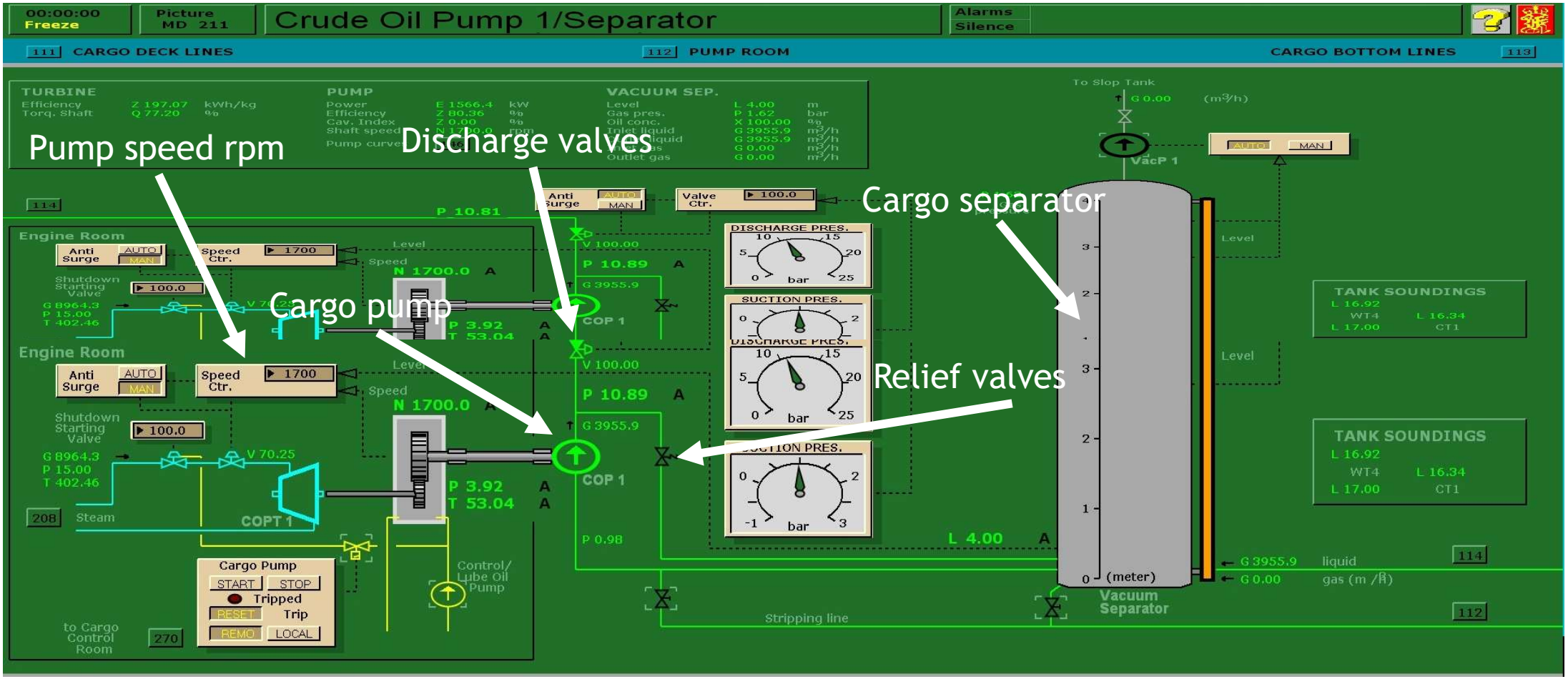
# Associated safety systems - surge relief

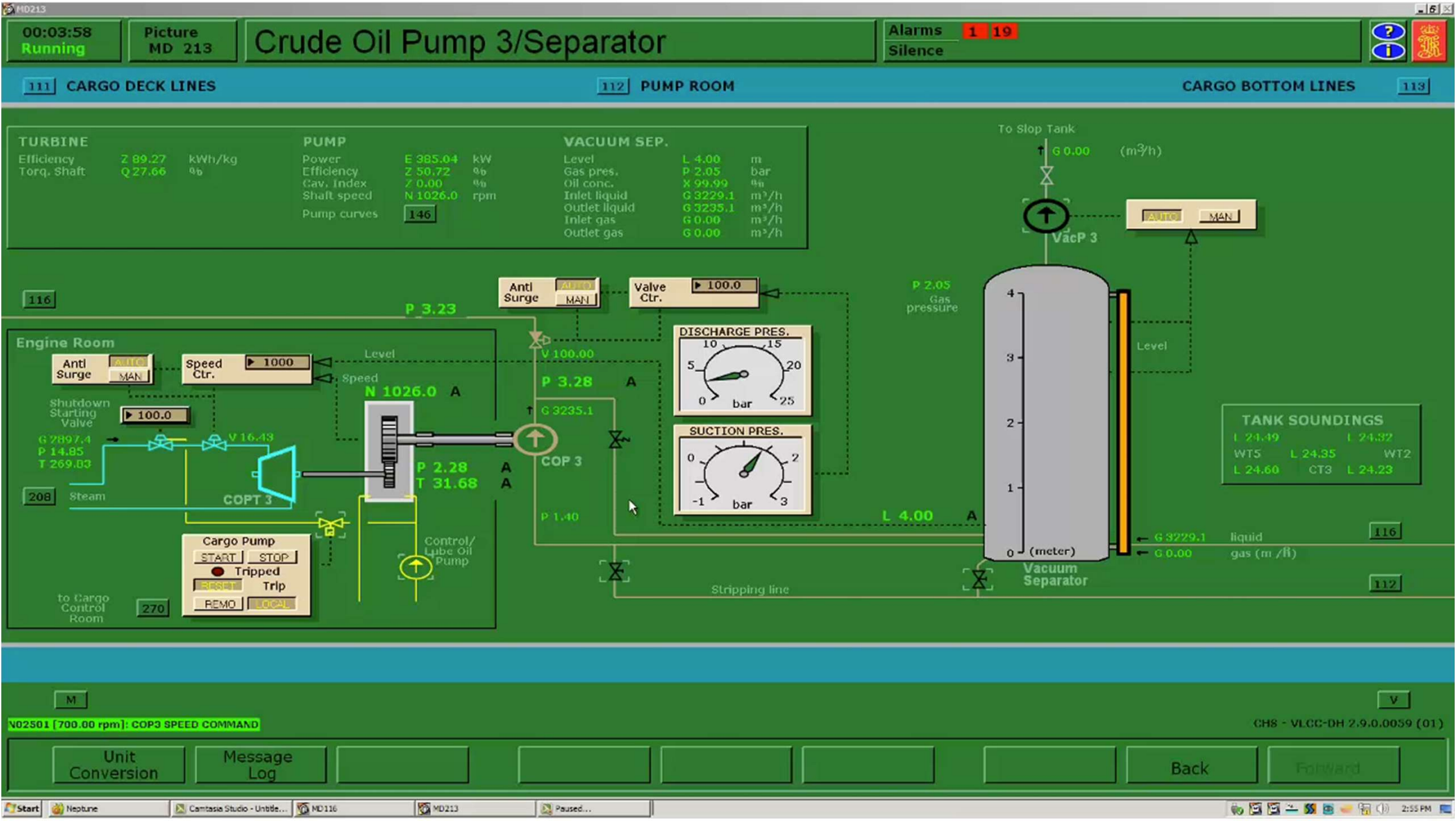
Some oil terminal arrangements incorporate a surge relief system.
At loading terminals, this may comprise a fast opening fail-safe dump valve that diverts liquid flow to a surge drum while the ESD and ERS valves are closing, minimising surge.



# Associated safety systems - surge relief

On crude oil tankers the relief valve (on by-pass line) between the cargo pump and discharging valve is used for protection the cargo system.
Relief valves allow to drop down the pressure in the system to the cargo pump separator.




00:03:58
Running
Picture
MD 213
Crude Oil Pump 3/Separator
Alarms 1 19
Silence
111 CARGO DECK LINES
112 PUMP ROOM
CARGO BOTTOM LINES
113
TURBINE
Efficiency Z 89.27 kWh/kg
Torq. Shaft Q 27.66 %
PUMP
Power E 385.04 kW
Efficiency Z 50.72 %
Cav. Index Z 0.00 %
Shaft speed N 1026.0 rpm
Pump curves 146
VACUUM SEP.
Level L 4.00 m
Gas pres. P 2.05 bar
Oil conc. X 99.99 %
Inlet liquid G 3229.1 m³/h
Outlet liquid G 3235.1 m³/h
Inlet gas G 0.00 m³/h
Outlet gas G 0.00 m³/h
To Slop Tank
G 0.00 (m³/h)
VacP 3
AUTO MAN
116
Anti Surge AUTO MAN
Valve Ctr. 100.0
P 3.23
P 2.05
Gas pressure
Engine Room
Anti Surge AUTO MAN
Speed Ctr. 1000
Level
Speed
N 1026.0 A
V 100.00
P 3.28 A
DISCHARGE PRES.
SUCTION PRES.
bar
Shutdown Starting Valve
100.0
G 2897.4
P 14.85
T 269.03
V 16.43
G 3235.1
COP 3
P 2.28 A
T 31.68 A
208 Steam
COPT 3
P 1.40
L 4.00 A
Level
TANK SOUNDINGS
L 24.49 L 24.32
WT5 L 24.35 WT2
L 24.60 CT3 L 24.23
Cargo Pump
START STOP
Tripped
RESET Trip
REMO LOCAL
Control/ Lube Oil Pump
G 3229.1 liquid
G 0.00 gas (m³/h)
116
(meter)
Vacuum Separator
Stripping line
112
to Cargo Control Room
270
M
V
N02501 [700.00 rpm]: COP3 SPEED COMMAND
CH8 - VLCC-DH 2.9.0.0059 (01)
Unit Conversion
Message Log
Back
Forward

# Conclusions

1. For the liquid cargo transfer some guidelines prepared by leading industry-related organisations exist.
2. ISGOTT is a main and basic guide for safety procedures in oil terminals, as well as onboard the tankers.
3. Ship/Shore Safety Check List (SSSCL) helps to the involved parties to determine potential hazards and provide safety-checks.
4. Human factor is one of the major elements that can lead to the accident in the oil terminal.
5. Emergency Shutdown System (ESD) – especially linked, is a critical tool to increase level of the safety during oil transfer between terminal and the vessel.
6. There are few additional systems related or connected to the ESD like Emergency Release System (ERS) or surge relief.
7. One of the best methods to increase the safety in human factor field is improvement of the skills by regular training.
8. Utilization of LCHS (Liquid Cargo Handling Simulators) could increase the safety level by gaining experience of the trainees and improving their knowledge.


# Thank you for your attention

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